

The Subseasonal Experiment (SubX)

Kathy Pegion

George Mason University, Dept of Atmospheric, Oceanic, and Earth Sciences
Center for Ocean-Land-Atmosphere Studies

Pegion, K. and Co-authors, 2018: The Subseasonal Experiment (SubX): A multi-model subseasonal prediction experiment, submitted to BAMS



OFFICE OF WEATHER AND AIR QUALITY



(a)

WEATHER FORECASTS

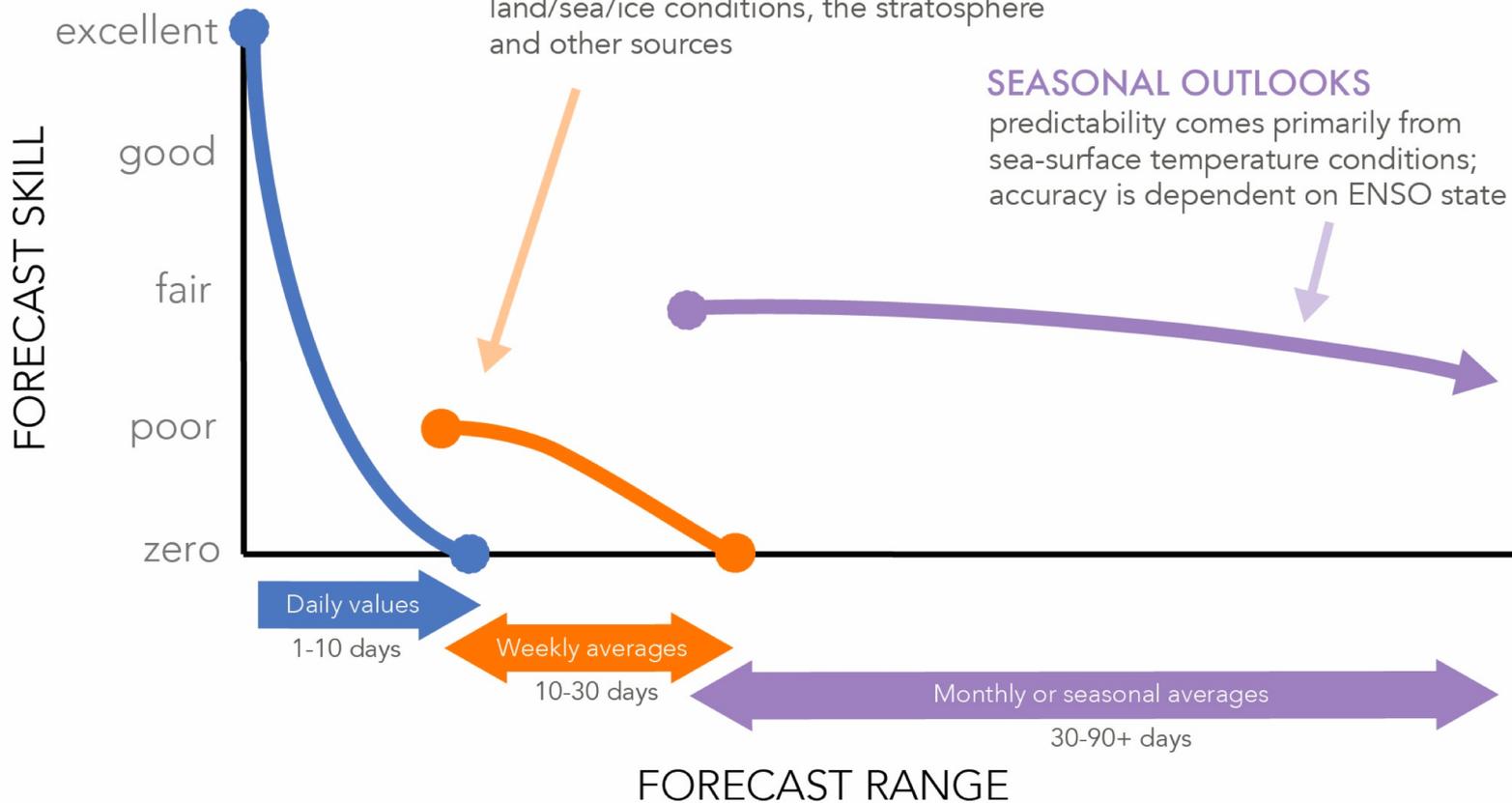
predictability comes from initial atmospheric conditions

S2S PREDICTIONS

predictability comes from initial atmospheric conditions, monitoring the land/sea/ice conditions, the stratosphere and other sources

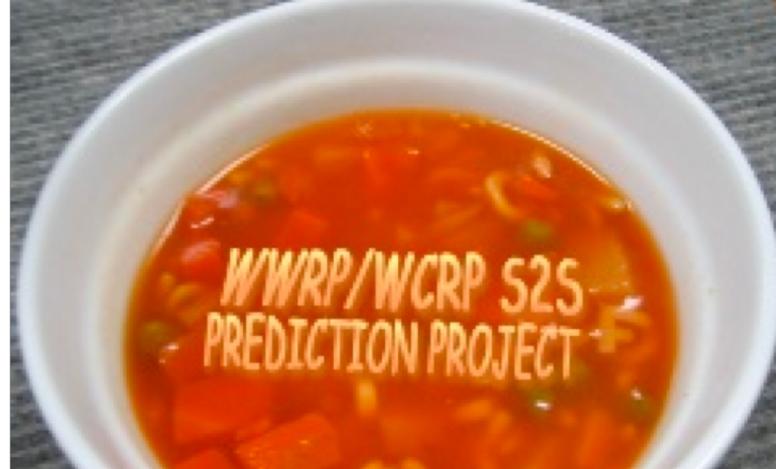
SEASONAL OUTLOOKS

predictability comes primarily from sea-surface temperature conditions; accuracy is dependent on ENSO state

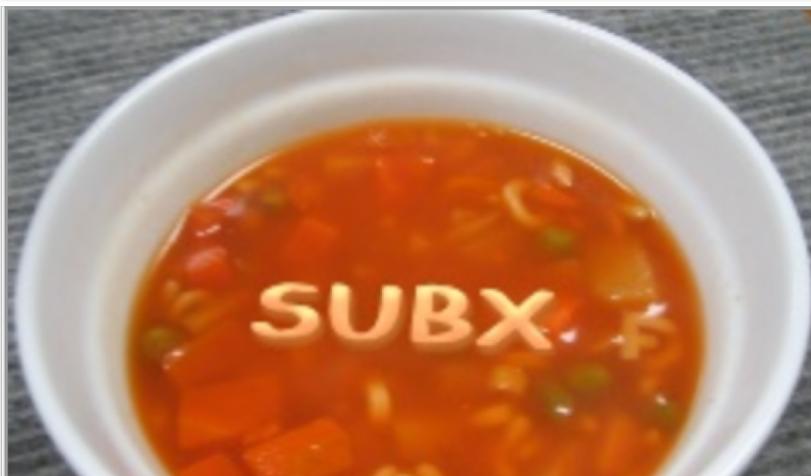




- Multi-model
- Monthly
- Re-forecasts & Forecasts
- Research & Predictions (R2O)



- International project
- Operational models
- Re-forecasts & Forecasts (delayed)
- Research



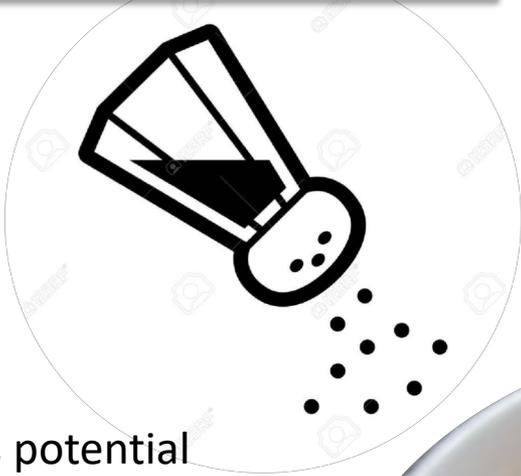
- Multi-model
- Subseasonal (weekly)
- Re-forecasts & Forecasts
- Research & Predictions (R2O)



- Collection of NOAA MAPP PIs
- Collaboration to understand S2S predictability & prediction
- Uses data from other S2S Projects

What is Unique about SubX?

**Forecasts available in
real-time**



Supports potential
use in real-time
applications

**Research models
included**



Facilitates model
development &
improvements



SubX BY THE NUMBERS

7 Global Models

1+ Years of *Real-time*
Forecasts

17 Years of
Retrospective Forecasts

3-4 week guidance
for Climate Prediction
Center Outlooks

The SubX Team

CORE TEAM

Ben Kirtman
Kathy Pegion
Tim DelSole
Michael Tippett
Andy Robertson
Michael Bell
Robert Burgman
Jon Gottschalck
Dan Collins
Emerson Lajoie
Hai Lin

NCEP-CFSv2

Dan Collins
Jon Gottschalck
Emerson Lajoie
Emily Becker
Kyle MacRitchie

Navy-ESM

Neil Barton
Joe Metzger

NCEP-GEFS

Yuejian Zhu
Wei Li
Eric Sinsky
Hong Guan

NCAR-CCSM4

Ben Kirtman
Dughong Min
Kathy Pegion
Ray Bell

NASA-GEOS5

Deepthi Achuthavarier
Randy Koster
Lena Marshak

ESRL-FIM

Shan Sun
Stan Benjamin
Ben Green

ECCC-GEM

Hai Lin
Bertrand Denis
Normand Gagnon

SubX Protocol

- Prediction System Details up to Provider
- Real-time and Retrospective Systems Identical
- Reforecast Period: 1999-2015
- At Least 3 Ensemble Members
- Minimum Length: 32 Days
- Real-time Forecast Made Available to CPC
Every Thurs by 6am of *Every week*
- Data on Uniform 1x1 Grid

Priority 1 Variables – Required to Support Operations

On 500 and 200 hPa levels

Variable	CF Standard Name	Abbrev	Unit	Frequency
Geopotential Height	geopotential_height	zg	m	Average of Instantaneous values at 0,6,12,18Z

On 850 and 200 hPa levels

Variable	CF Standard Name	Abbrev	Unit	Frequency
Zonal Velocity	eastward_wind	ua	ms-1	Average of Instantaneous values at 0,6,12,18Z
Meridional Velocity	northward_wind	va	ms-1	Average of Instantaneous values at 0,6,12,18Z

On a single level

Variable	CF Standard Name	Abbrev	Unit	Frequency
2m Temperature	air_temperature	tas	K	Daily Average
Precipitation	precipitation_flux	pr	kgm-2s-1	Accumulated every 24hrs
Surface Temperature (SST+Land)	surface_temperature	ts	K	Daily Average
Outgoing Longwave Radiation at top of Atm	toa_outgoing_longwave_flux	rlut	Wm-2	Accumulated every 24hrs

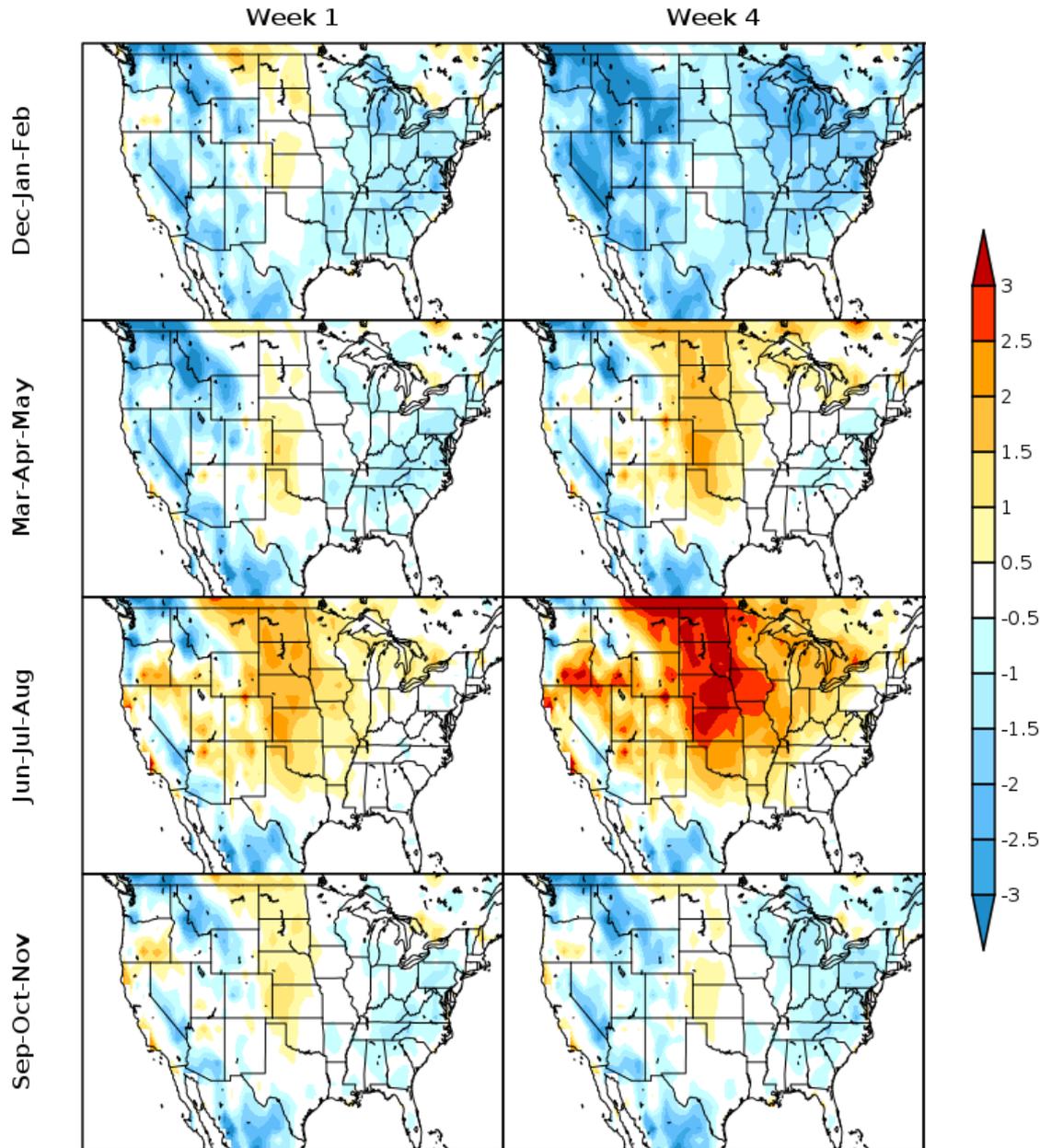
SubX Models

Model	Components	Ensemble Members	Length (Days)
NCEP-CFSv2	A,O,I,L	4	45
EMC-GEFS	A,L	11 [21]	35
ECCC-GEM	A,L	4 [21]	32
GMAO-GEOS5	A,O,I,L	4	45
NRL-NESM	A,O,I,L	4	45
RSMAS-CCSM4	A,O,I,L	3 [9]	45
ESRL-FIM	A,O,I,L	4	32

SubX Current Status & On-going Activities

- ✓ Re-forecast & real-time forecast database
- ✓ Real-time forecast maps
- ✓ Real-time forecast data to NCEP/CPC
- ✓ Re-forecast Evaluation: probabilistic and deterministic skill, bias
- ✓ Sources of predictability/phenomena: MJO, NAO

SubX Multi-model Biases 2m Temperature

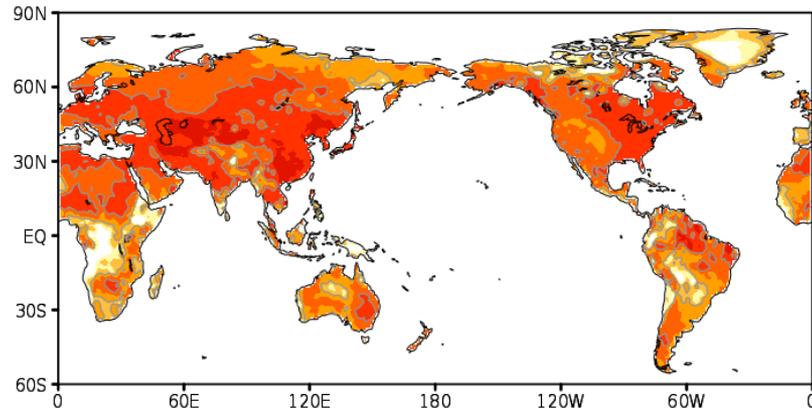


- Bias patterns established in week 1, grow into week 4
- Summer warm/dry bias

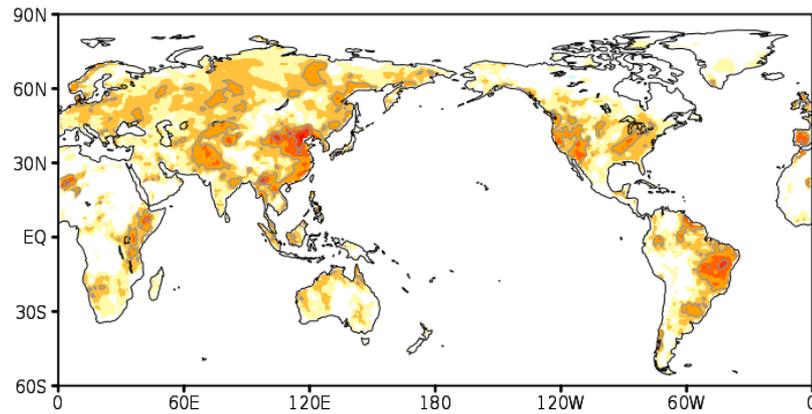
SubX Multi-model Week 2 Skill Dec-Jan-Feb

Anomaly Correlation

2m Temperature



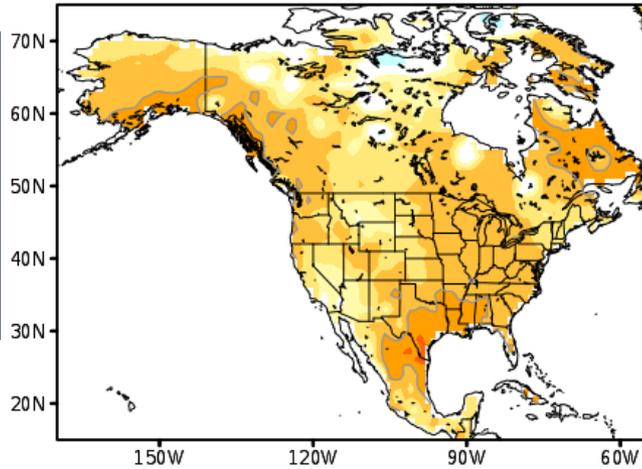
Precipitation



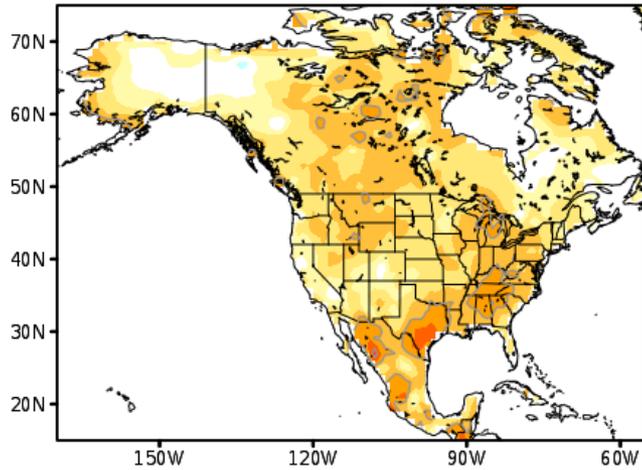
SubX Multi-model Anomaly Correlation Week 3-4

2m Temperature

a) 2m Temperature Dec-Jan-Feb

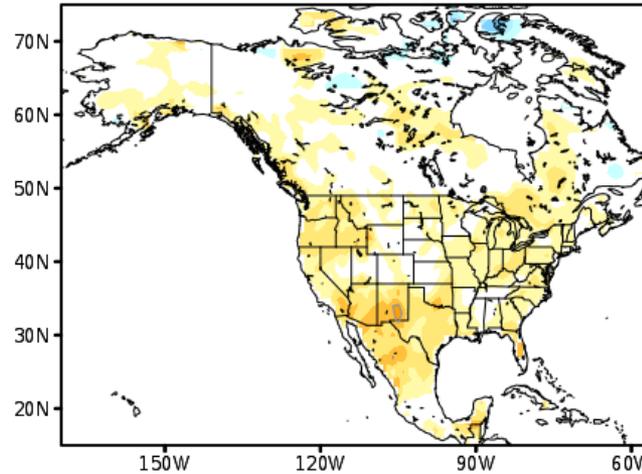


c) 2m Temperature Jun-Jul-Aug

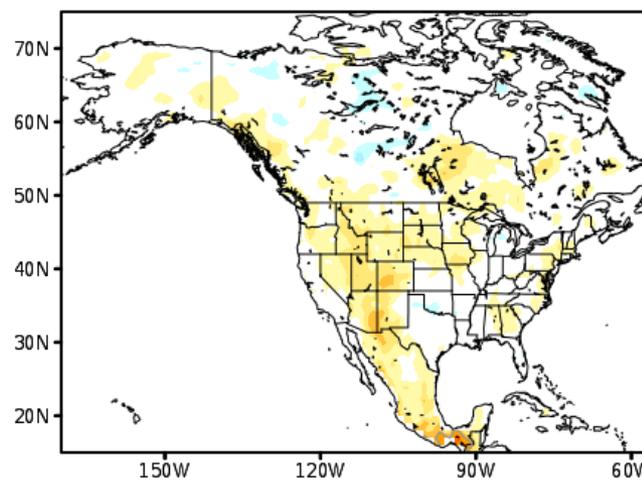


Precipitation

a) Precipitation Dec-Jan-Feb



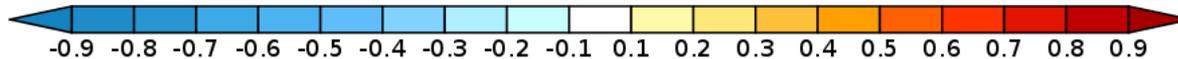
c) Precipitation Jun-Jul-Aug



Winter

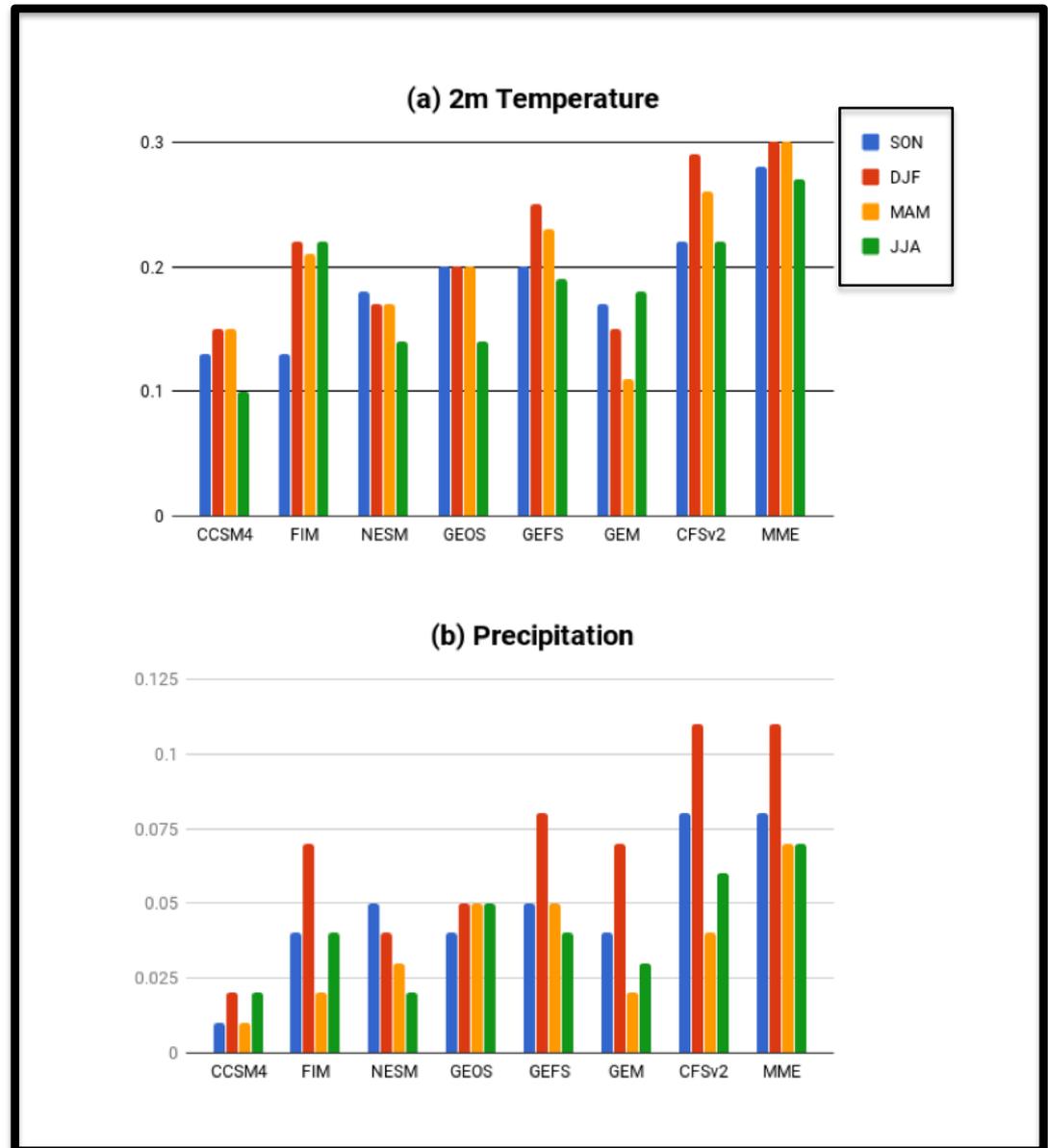
Summer

- Skill is positive
- There is "useful" skill for some regions and seasons



SubX Average Anomaly Correlation North America Week 3-4

- MME more skillful than individual models in all seasons
- No stratification of skill by model configuration



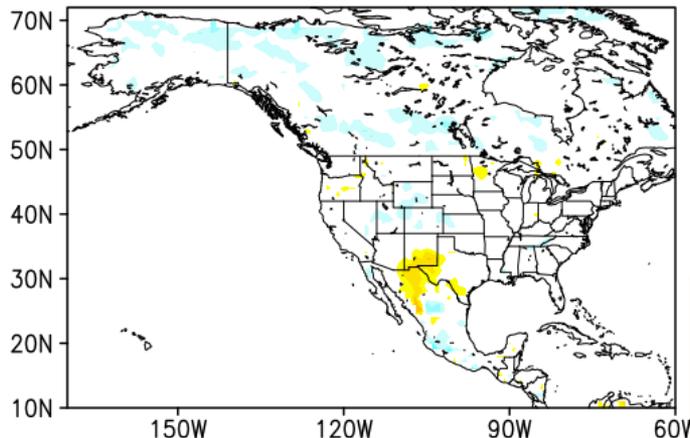
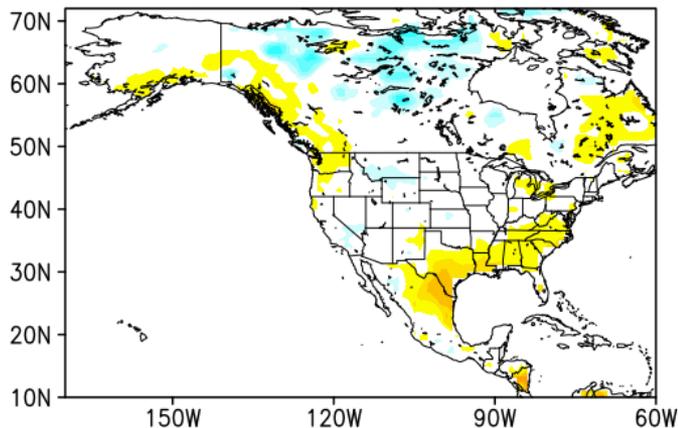
SubX Multi-model RPSS Week 3-4

2m Temperature

Precipitation

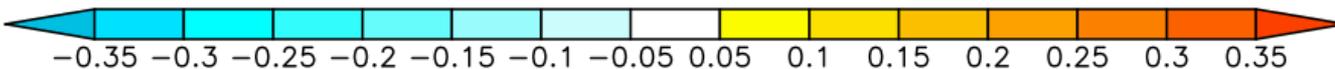
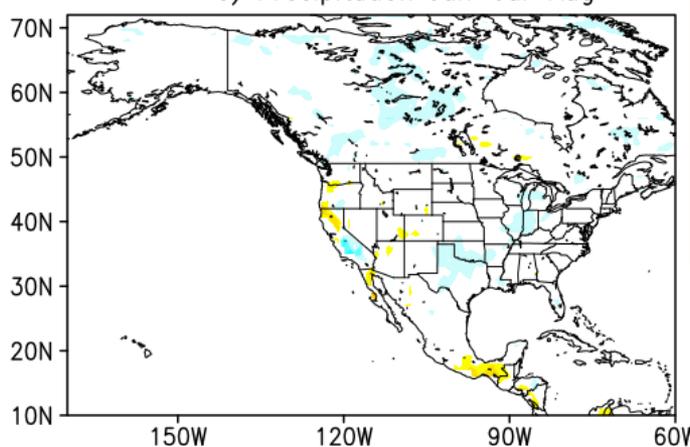
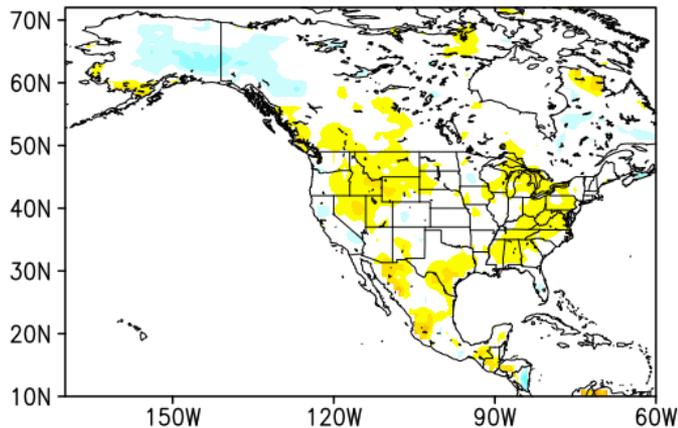
a) 2m Temperature Dec–Jan–Feb

a) Precipitation Dec–Jan–Feb



c) 2m Temperature Jun–Jul–Aug

c) Precipitation Jun–Jul–Aug



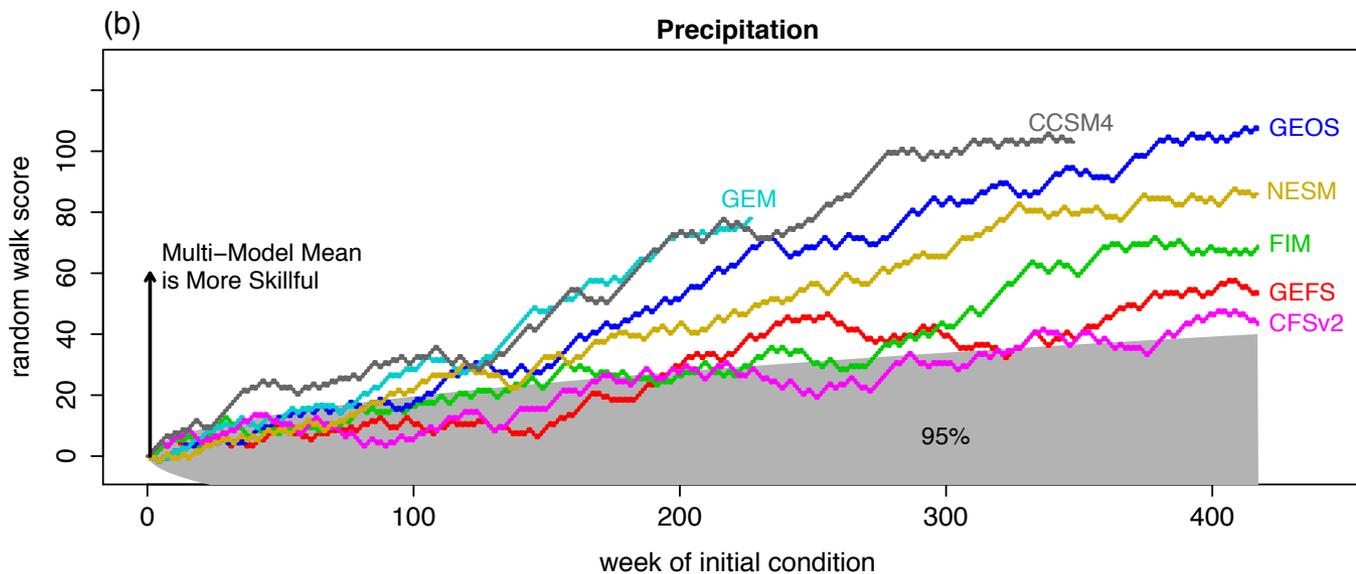
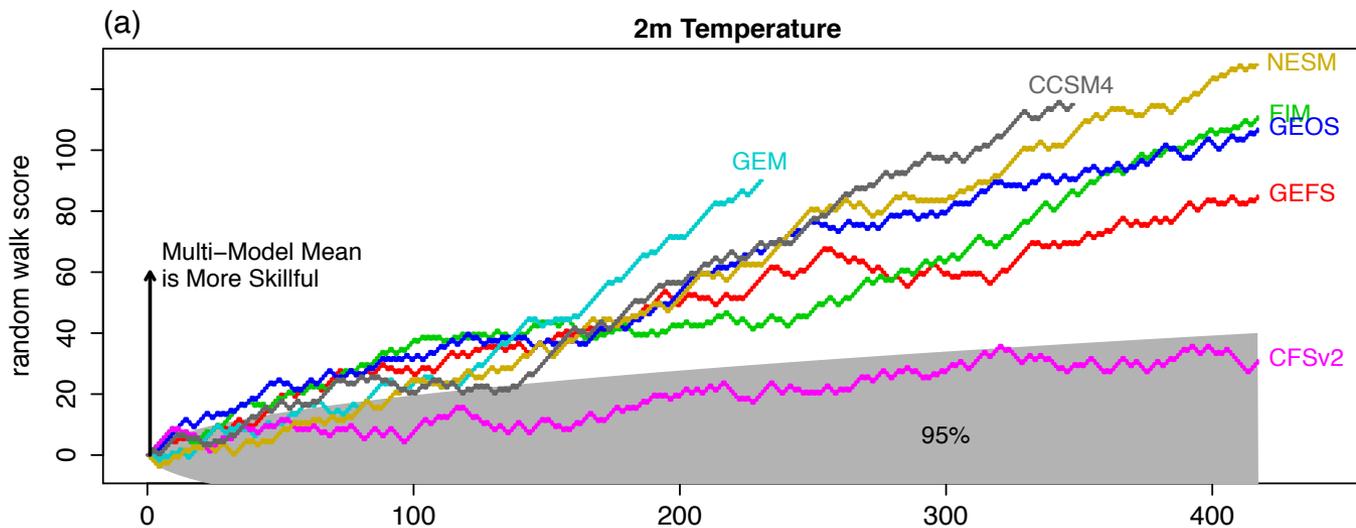
Winter

Summer

- Consistent with ACC
- There is skill for T2M
- Little skill for precip

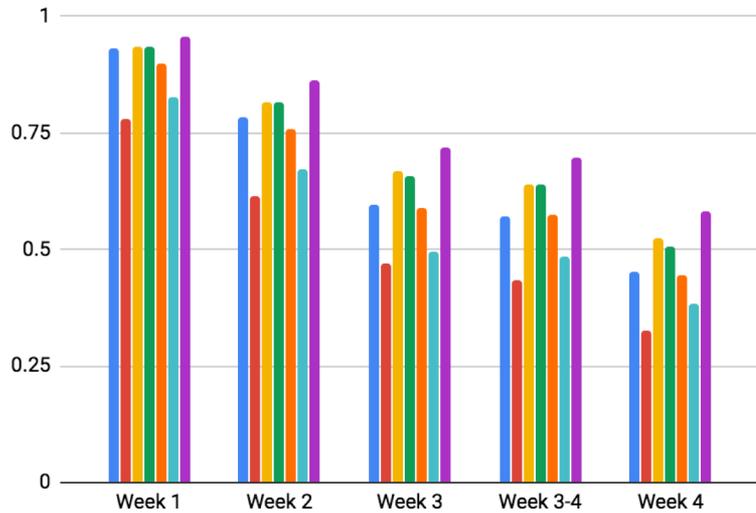
Benefit of SubX MME

Random Walk Test for Comparing Multi-Model Mean to SubX Models
Week 3-4 Hindcasts; Pattern Correlation; US and Canada

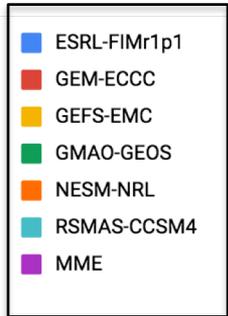
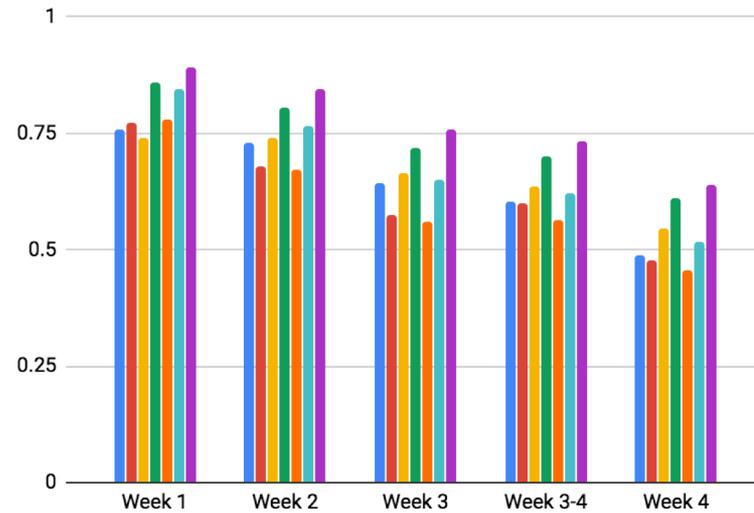


MJO Skill: Anomaly Correlation

RMM Index

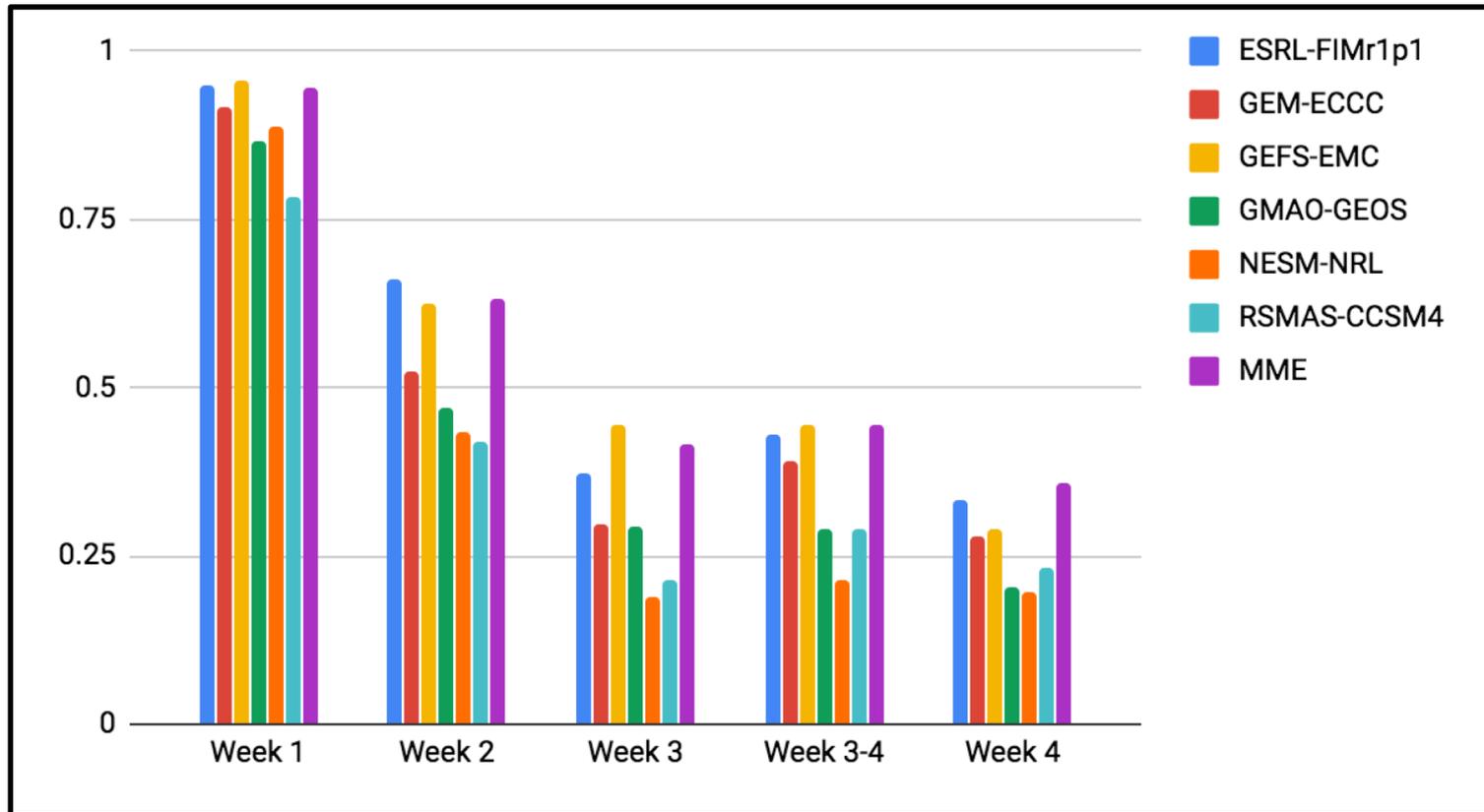


ROMI Index



- Skill >0.5 at week 3-4
- Skill is similar to WWRP/WCRP S2S Models
- Two most skillful models have very different configurations
- MME has higher skill than individual models

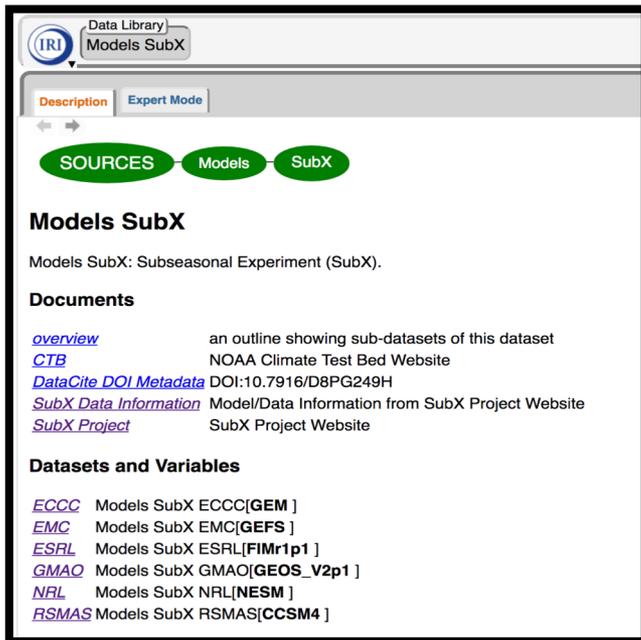
NAO Skill: Anomaly Correlation



- Skill below 0.5 after week 2
- MME has similar skill to best models
- Two best models have similar configurations

Real-time Forecasts

- CPC processes for their week 3-4 outlooks
- SubX Team processes for publicly available forecast plots
- All data are publicly available



IRI Data Library
Models SubX

Description Expert Mode

SOURCES Models SubX

Models SubX

Models SubX: Subseasonal Experiment (SubX).

Documents

overview	an outline showing sub-datasets of this dataset
CTB	NOAA Climate Test Bed Website
DataCite DOI Metadata	DOI:10.7916/D8PG249H
SubX Data Information	Model/Data Information from SubX Project Website
SubX Project	SubX Project Website

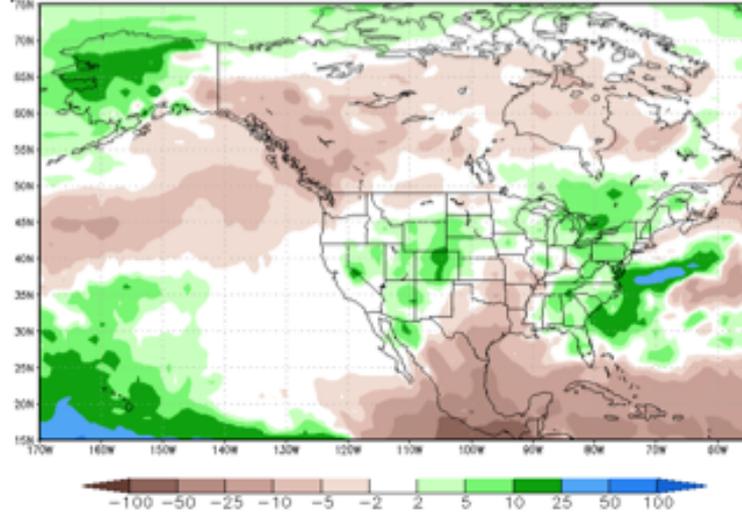
Datasets and Variables

ECCC	Models SubX ECCC[GEM]
EMC	Models SubX EMC[GEFS]
ESRL	Models SubX ESRL[FIMr1p1]
GMAO	Models SubX GMAO[GEOS_V2p1]
NRL	Models SubX NRL[NESM]
RSMAS	Models SubX RSMAS[CCSM4]

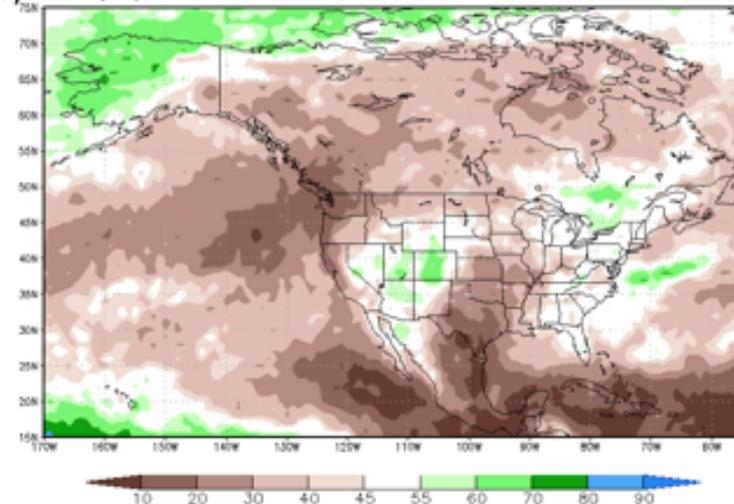
<http://iridl.ldeo.columbia.edu/SOURCES/.Models/.SubX/>

Example SubX Forecast Guidance & CPC Outlook

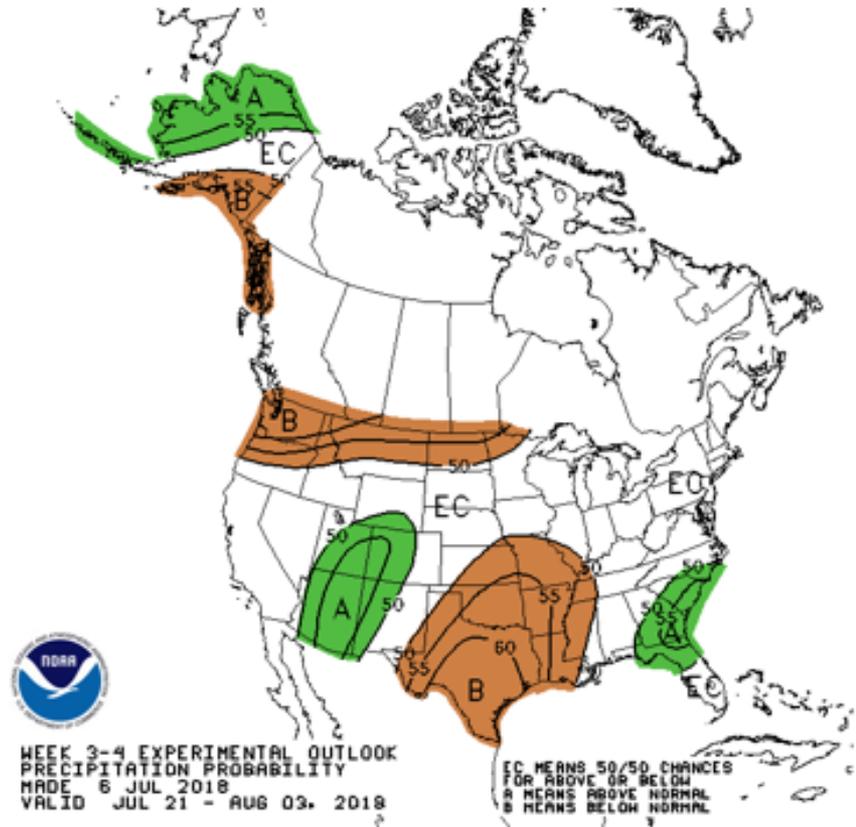
d) MME (79) P anom Issued: 06 Jul 2018 Valid: 21 Jul - 03 Aug



e) MME (79) P Prob Issued: 06 Jul 2018 Valid: 21 Jul - 03 Aug



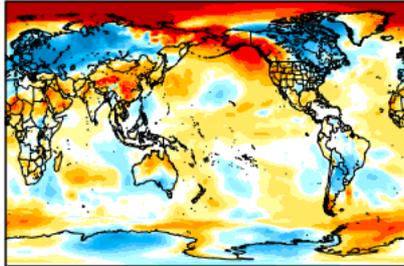
f) NOAA/CPC Precipitation Outlook



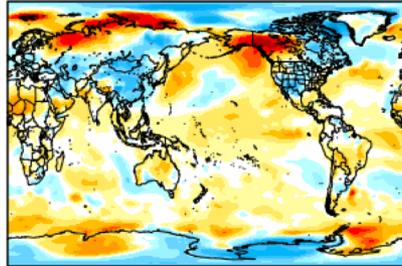
Example: Real-time forecast maps on SubX Website

SubX Week 3-4 2m Temperature Anomalies (deg C): Valid 2 weeks ending NOV 16

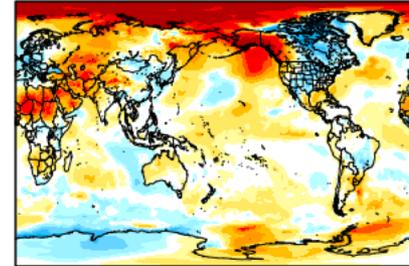
ESRL-FIMr1p1 (IC: 10/17 ; 4 Ens)



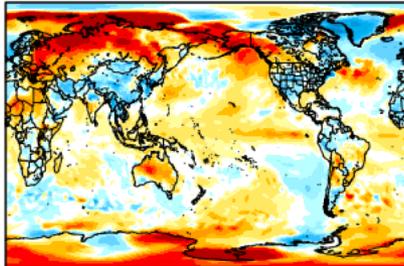
RSMAS-CCSM4 (IC: 10/14 ; 9 Ens)



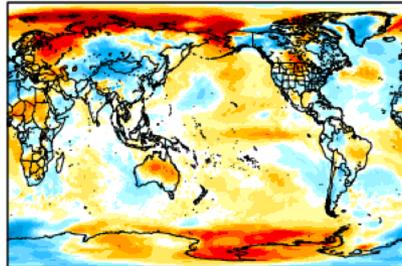
EMC-GEFS (IC: 10/17 ; 21 Ens)



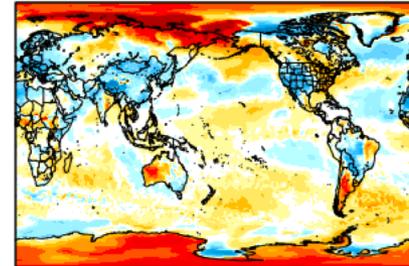
GMAO-GEOS_V2p1 (IC: 10/13 ; 4 Ens)



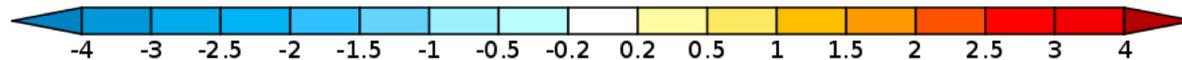
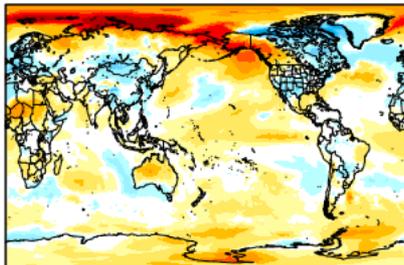
NRL-NESM (IC: 10/13-10/16 ; 4 Ens)



ECCC-GEPS5 (IC: 10/18 ; 21 Ens)



MME (63 Ensemble Members)



<http://cola.gmu.edu/kpregion/subx/forecasts/forecasts.html>

Summary

- **SubX provides a publicly available re-forecast and real-time forecast database for S2S research, operations, and applications.**
- **SubX Complimentary to other S2S efforts:**
 - real-time forecasts
 - research models
- **Evaluation of model biases, skill, sources of predictability demonstrate skill at subseasonal timescales in specific regions and seasons and benefit of MME**
 - Much more to be done
- **SubX provides useful contributions to operational week 3-4 forecast guidance**
 - What can we do to provide more useful information?
 - Emerson Lajoie's Talk this afternoon
- **SubX is an ideal framework for testing model improvements/new models**
 - E.g. CESM, UFS

Where to find more information: <http://cola.gmu.edu/kpegon/subx/>

cola.gmu.edu/kpegon/subx/index.html

Home About People Data Forecasts Model Evaluation Related Projects

Evaluation of Subseasonal forecasts for Weather and Climate Events

Learn More

News

Now Available! [SubX User's Guide](#)
SubX Data at IRI has a DOI: [10.7916/D8PG249H](https://doi.org/10.7916/D8PG249H)
[More News »](#)

Forecasts

The SubX project makes experimental real-time forecasts each week. Forecasts maps are typically updated on Saturdays. Users can select to view static or interactive forecast maps
[Static Forecast Maps »](#)

Data

SubX retrospective forecasts and real-time forecast data are publicly available via the [IRI Data Library](#). The SubX project also provides detailed information about the participating [models](#), [available variables](#), [current data holdings](#), and tools for downloading data. [Learn More »](#)
[Get Data »](#)

- Submitted BAMS Paper
- SubX Data Users Guide
- Codes for Downloading and processing data
- Model Evaluation Plots
- Real-time Forecast Plots